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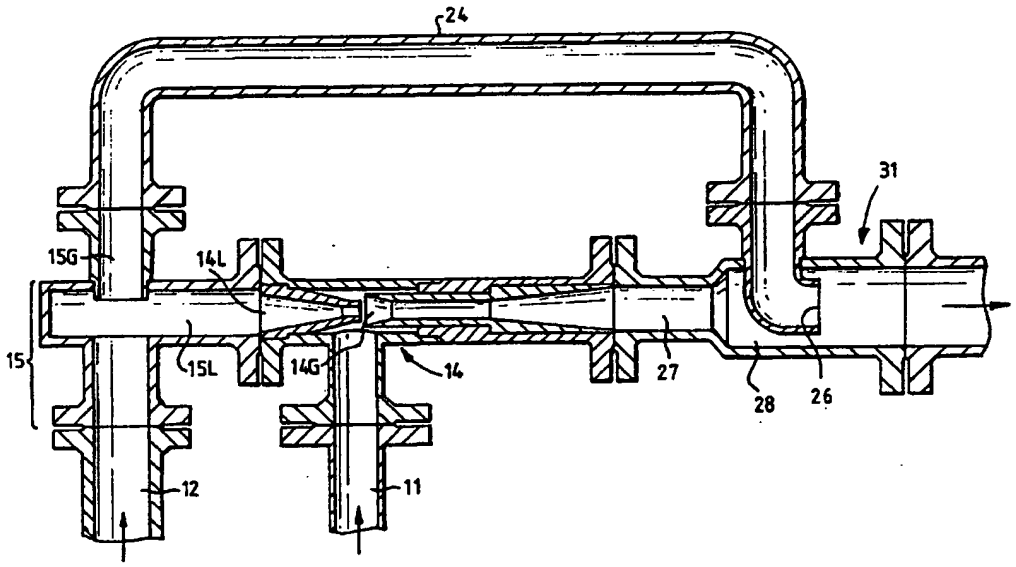

(57) Abstract

A co-mingling device comprises a jet pump (14) and a phase separator (15). The jet pump has a primary fluid which is a driving fluid and a secondary fluid which is the driven fluid. It is particularly important that the primary fluid is consistent in phase, and to avoid undue phase variations, the present invention includes the phase separator (15) in the primary fluid supply, directing liquid-rich fluid (15L) to the primary fluid input (14L) of the jet pump. The gas-rich fluid 15G can bypass the jet pump in (24) and be mingled at (28) with the output of the jet pump if desired.

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SYSTEM FOR PUMPING LIQUIDS USING A JET PUMP

Jet pumps operate by introducing a high pressure or primary fluid through a nozzle and allowing the low pressure or secondary fluid to be entrained into the flow stream. Due to the momentum exchange between the two fluids the resulting pressure of the combined stream will be increased to well above the pressure of the secondary fluid.

An application of mingling liquids is in fuel extraction. Gas or liquid or a mixture of the two phases is extracted from a fuel field. Many fields have a significant variation in production characteristics because of reservoir fragmentation and presence of different production zones. This often results in wells having different flowing wellhead pressures.

Conventional mingling of the products from such wells results in the need to choke the production from the high pressure wells and restricts the production from the low pressure wells. This is costly and inefficient and does not result in optimum recovery.

Jet pumps can be used for such mingling and work satisfactorily when the primary and secondary fluids are both liquids, or both gases. In addition, jet pumps can also be designed to operate satisfactorily when the primary fluid is pure liquid and the secondary fluid consists of a liquid/gas mixture. However satisfactory, jet pump operation cannot be achieved when there is a wide variation in the phase proportions in the primary fluid.

The present invention is aimed at overcoming this problem by providing a co-mingling device in which the jet pump is provided with a phase separator in the primary line, and utilising the liquid phase obtained from the

separator as the primary fluid of the jet pump. A bypass arrangement may be provided for the separated gas phase to be mixed back into the fluids from the outlet of the jet pump.

Examples of the invention will now be described with reference to the accompanying drawings in which:-

Figure 1 is a diagrammatic representation of a co-mingling device,

Figure 2 is a diagram of the device of Figure 1,

Figure 3 is a diagram of a similiar co-mingling system, incorporating two jet pumps,

Figure 4 shows a co-mingling system which is also a separating system, co-mingling the separated fluids, and

Figure 5 is an elaboration of Figure 4.

In Figures 1 and 2, fluids from separate sources are co-mingled in a jet pump 14. Sources of high and low pressure fluids for the jet pump are obtained in this example from underground oil wells, a first source of fluid 11 under low pressure and a second source of fluid 12 under high pressure. Both fluids are mixtures of gas and liquid. The fluid from the high pressure oil well is used to pump fluid from the low pressure well.

The fluid mixture under low pressure is supplied to the low pressure inlet 14G of a conventional jet pump 14. The high pressure fluid passes first to an in-line separator 15, in which the lighter phase tends to return to the line of entry and the heavier fluids are deflected from that line. This is usually achieved by imparting a swirl to the incoming fluid, the centrifugal force acting to separate the different phases. The gas rich fluid tends to collect along the axis of the swirl, in line with the incoming fluid and the heavier phase is collected from an off-axis outlet.

The liquid phase (or liquid rich fluid) 15L separated from the high pressure fluid is supplied as primary fluid to the high pressure inlet 14L of the jet pump 14. The gas-rich phase 15G separated from the high pressure fluid passes through a bypass conduit 24, and the conduit may be provided with a device for controlling the flow of the gas in the bypass conduit; the device may be an orifice plate, a nozzle (as illustrated at 26) at the end of the bypass conduit 24 or a controllable valve, which is useful when inlet pressures may vary during operation.

Since the primary fluid reaching the high pressure inlet 14L of the jet pump is substantially all liquid phase, the jet pump 14 operates satisfactorily to draw low pressure fluid from the first source through the pump and the mixture of liquids passes from the jet pump outlet 27, into a mixing device 28 where it is mixed with the gas stream from the separator 15.

It will be noted that the mixing device 28 is housed in an extension of the outlet pipe 31 of the jet pump; the diameter of the extension increases in the region of the entry of the gas bypass conduit outlet. The role of the mixing device is to allow efficient entry of the bypass gas into the fluid leaving the jet pump. Since the pressure of the two fluids may be comparable at this point the mixing device must reduce the effect which the high pressure bypass gas may have in restricting the flow out of the jet pump. In fact the bypass gas is problably at a higher pressure than the fluids in the outlet of the jet pump and so it is preferable for the outlet of the bypass conduit to form what can be seen as another jet pump in the outlet conduit from the main jet pump, thus assisting the flow of fluids from the main jet pump, recovering momentum lost from the high pressure oil stream at the phase separator. Certainly the bypass gases should be introduced in a streamline manner, such as by directing the gases axially

along the outlet conduit, to prevent any disruption of the flow from the outlet of the main jet pump. The effect of the outlet fluids from the main jet pump on the flow of gas in the bypass conduit controls the operation of the phase separator; its back pressure discourages any carry-over of liquid slugs through the bypass conduit; it is thus a passive controller.

The gas from the separator 15 need not be mixed back with the output fluids from the jet pump. The gas may for example be fed to a flare or a fuel system.

In Figure 3 there are two jet pumps 31, 32 in parallel and two phase separators 41, 42, one in the supply from each well. The first jet pump 31 receives liquid at each of its inputs, the liquid phase output 41L from the high pressure well separator 41 as its primary fluid and the liquid phase output 42L from the low pressure well separator 42 as its secondary input, co-mingling them to produce a liquid supply 43L to the single mixing device 43. The second pump 32 receives gas-rich fluid at each of its inputs, the gas phase output 41G from the high pressure well separator 41 as its primary fluid and the gas phase output 42G from the low pressure well separator 42 as its secondary fluid, comingling the gases to produce a gas supply 43G to a single mixing device 43. Jet pumps receiving the same phase for primary and secondary fluids have improved performance, as was pointed out in the introduction to the specification.

The jet pump 14 in Figures 1 and 2 has a liquid enriched supply of driving fluid, but the supply from the low pressure well is unseparated and so may contain unsatisfactory amount of gas. In Figure 3 both jet pumps 31, 32 have phase separated supplies and so do not have to deal with such a wide range of phase proportions; they can

therefore be much more closely designed and so should work more efficiently.

It would be possible for the high pressure inlet of the jet pump to be supplied from the liquid rich output of the phase separator boosted in pressure for example by a pump and for the low pressure input of the jet pump to be supplied from the gas rich outlet of the phase separator. As shown in Figure 4, there is only one phase separator 51 and one manifold inlet 52 from an oil field. The jet pump 53 receives fluid at 53L from the liquid rich outlet 51L of the separator 51 after boosting in pressure by a pump 55. The gas rich outlet 51G of the separator is not boosted and so is at relatively low pressure at the low pressure inlet 53G to the jet pump. The jet pump has a narrow range of phase proportions to deal with as its primary fluid and operates efficiently to co-mingle the gas and liquid phases from the oil field.

Figure 4 shows the arrangement of Figure 3 with the output from a second manifold 61 of fluids at higher pressures. The second manifold is connected to the output 56 of the jet pump 53 by a further co-mingler 62, which may be another jet pump or a general mixing device, as described above.

CLAIMS

1. A co-mingling device comprising a jet pump (14, 32, 53) having a high pressure inlet (14L, 32L, 53L), a low pressure inlet (14G, 32G, 53G) and a main outlet (27, 43L, 56), characterised by a phase separator (15, 42, 51) having a liquid-rich outlet (15L, 42L, 51L) connected to said high pressure inlet.

2. A device as claimed in claim 1 wherein the phase separator has a gas-rich outlet (14G, 32G, 53L) which is connected to said main outlet.

3. A device as claimed in claim 2 wherein the gas-rich outlet is connected to said main outlet by means of a nozzle (26) directed along the axis of the main outlet.

4. A device as claimed in claim 1 wherein the phase separator has a gas rich outlet (51G) which is connected to said low pressure inlet (53G), means (55) being provided between the liquid rich outlet (51L) and the high pressure inlet (53L) to increase the pressure of fluid passing therethrough.

5. A co-mingling device as claimed in claim 1 where said jet pump is a first jet pump (31) having a high pressure inlet, a low pressure inlet and a main outlet, and said phase separator is a first phase separator (41) having a liquid-rich outlet connected to said high pressure inlet of the first jet pump, the device comprising a second jet pump (32) having a high pressure inlet, a low pressure inlet and a main outlet, and a second phase separator (42) having a liquid-rich outlet connected to said low pressure inlet of the first jet pump, the first phase separator having a gas rich outlet connected to the high pressure inlet of the second jet pump and the second gas separator having a gas

rich outlet connected to the low pressure inlet of the second jet pump.

6. A device as claimed in claim 5 comprising means (43) to mix the outlets of the two jet pumps (31, 32).

7. A device as claimed in any one of claims 1 to 6 wherein the or each phase separator is an in-line separator, the gas-rich outlet (15G, 41G, 51G) being aligned with the inlet of the phase separator.

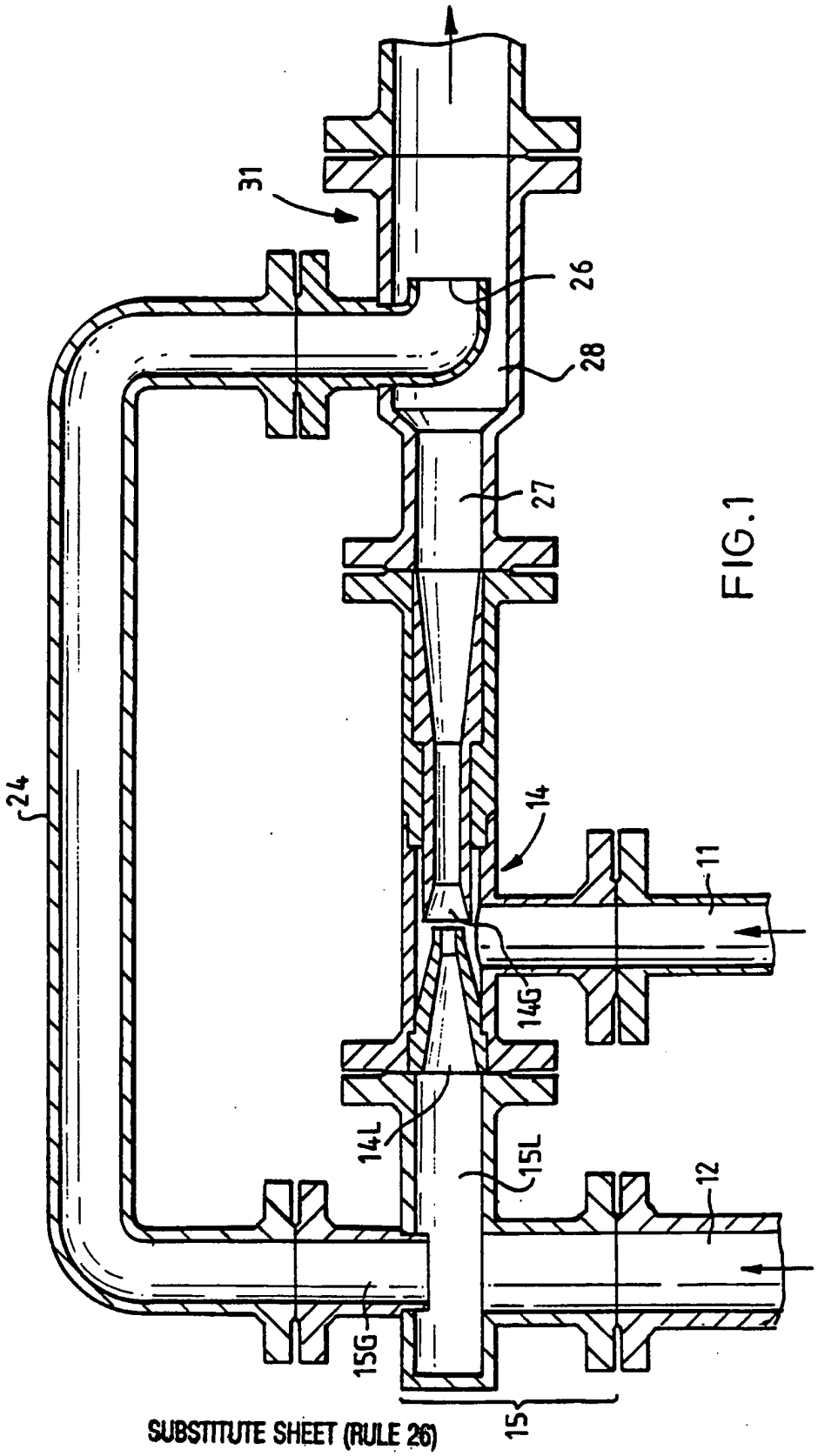

FIG.1

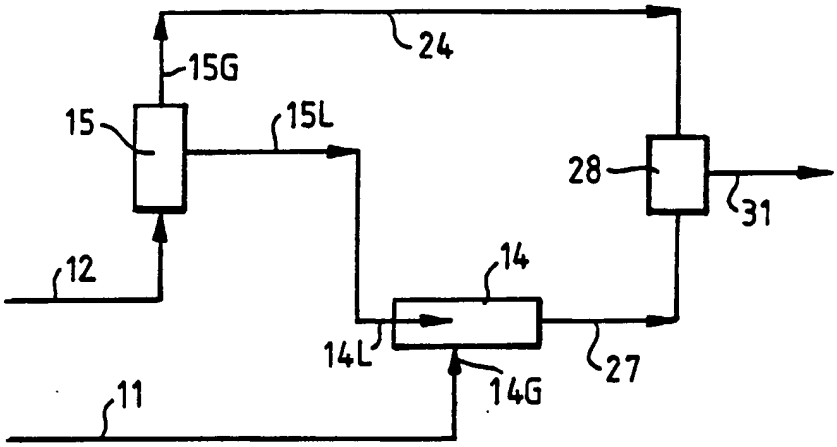
24
15G
15
15L
28
31
12
14
14L
27
14G
11

FIG. 2

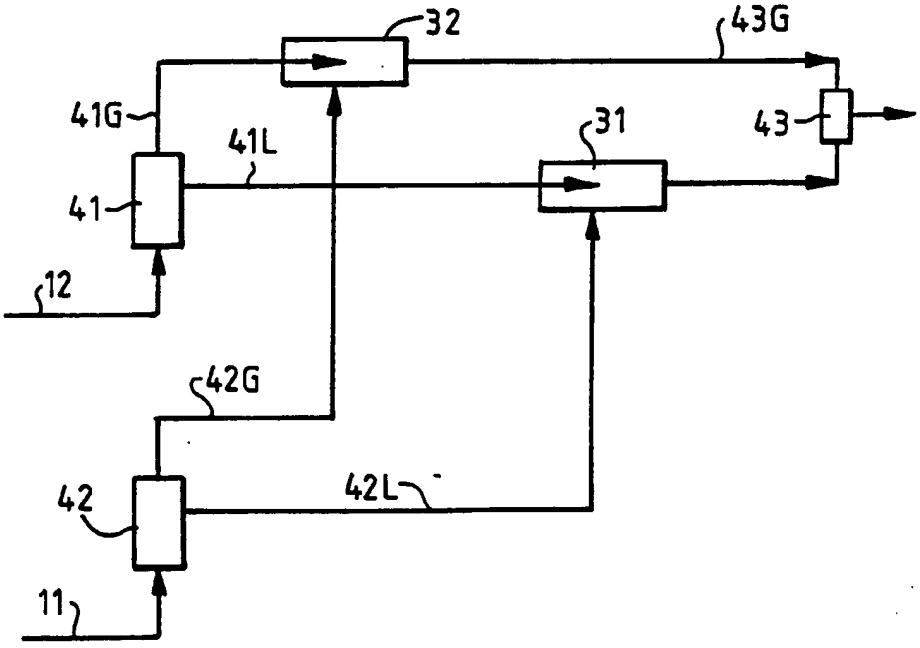
32
43G
41G
41L
31
43
41
12
42G
42
42L
11

FIG. 3

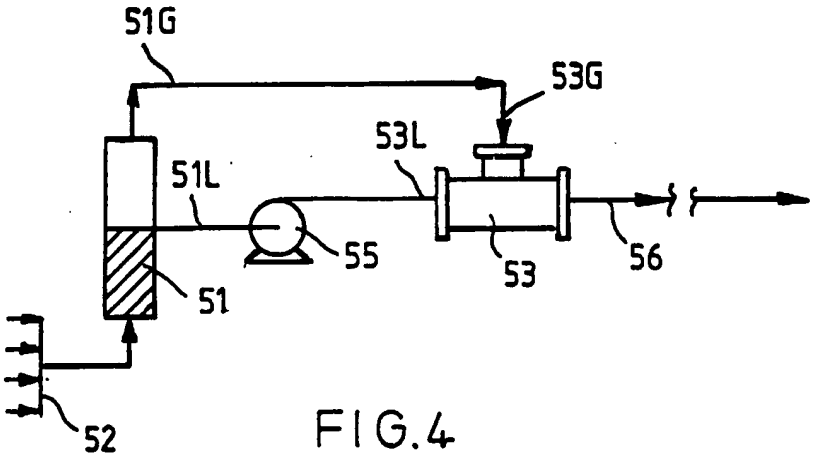

FIG.4

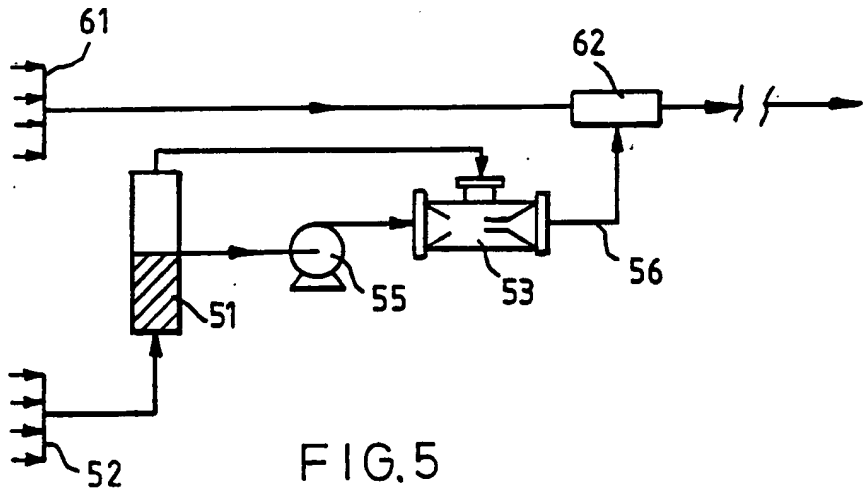

FIG.5

INTERNATIONAL SEARCH REPORT

Intern al Application No
PCT/GB 94/01937

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F04F5/10 E21B43/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F04F E21B F04D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB,A,2 264 147 (PECO MACHINE SHOP & INSPECTION SERVICES LTD.) 18 August 1993 see page 7, line 14 - line 32; figure 3 ---	1
A	GB,A,2 239 676 (B.H.R. GROUP LTD.) 10 July 1991 see page 1, line 18 - line 26; figure 1 ---	1
A	GB,A,2 101 216 (THE PLESSEY COMP.) 12 January 1983 see page 1, line 86 - line 99; figures 1,6 -----	1

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☒ Patent family members are listed in annex.

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GB-A-2264147	18-08-93	NONE		
GB-A-2239676	10-07-91	NONE		
GB-A-2101216	12-01-83	DE-A,C	3221231	13-01-83
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